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Assessment of Heavy Metals in Fodder Crops Leaves Being Raised with Hudiara Drain Water (Punjab-Pakistan)

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***Abstract*—** *The present study was designed with the objectives to assess heavy metals' concentration in Hudiara drain water and investigation of the concentration of heavy metals in different fodder crops grown with this drain water and the determination of heavy metals in milk of cattles grazing these contaminated fodder crops. A survey was conducted and ten different sites were selected along Hudiara drain after entering Lahore. Five water samples and three samples of crops from a each site. The samples were processed, stored and then analyzed for heavy metals like Lead, Cadmium, Chromium, Nickel, Zinc, Iron, Copper and manganese. Lead pollution was not found, whereas, Cadmium, Chromium and Nickel contamination was shown in Hudiara drain water. Similarly, Zinc pollution was not found in Hudiara drain water regarding irrigation and Iron, Copper and Manganese contamination was present in Water samples. Most of the fodder crops samples were contaminated with all heavy metals having levels of heavy metals above the Recommended Concentrations. It is noted that* Pb^{+2} *of Hudiara drain and irrigated* Pb^{+2} *of fodder crop were in positive correlation and negative correlation between* Pb^{+2} *and* Cr^{+2}, Ni^{+2}, Cu^{+2}. *There is positive correlation between* Cd^{+2} *and* Cr^{+2}, Fe^{+2} *and also negative correlation between* Cd^{+2} *and* Pb^{+2}, Cd^{+2}, Ni^{+2}, Zn^{+2}, Cu^{+2}, Mn^{+2} *of fodder crop irrigated with Hudiara drain.*

Keywords*—*Heavy Metals, Hudiara Drain, Fodder crops, Water samples.

I. INTRODUCTION

Industrial effluents are the most potential water pollutants [1]. The effluxents discharged by different industries have higher values of physico-chemical parameters like temperature, pH, conductivity, hardness, alkalinity, chemical oxygen demand, total soluble salts, nitrates, nitrites and cations (Na, K, Ca and Mg) [2]. This water also contains significant amount of heavy metals such as zinc, iron, copper, manganese, lead, cadmium, chromium, nickel, cobalt, arsenic etc. [3]. Some of the heavy metals are essential and some are even not essential for plant growth but after accumulating in the soil could be transferred to food chain [4]. Generally, farmers are not aware of the metal ion toxicity being introduced into food chain by vegetables grown with such polluted waters [5]. If these heavy metals leach out through the soil, they may also contaminate ground-water [6].

Hudiara Drain, which is a long natural storm water channel, originates from Batala in Gurdaspur District, India and after flowing nearly 55 km on Indian side at village Laloo enters Pakistan at Hudiara village on Pakistan side. After flowing for nearly 63 km inside Pakistan, it joins the river Ravi. The river Ravi has serious pollution problems. There are around hundreds of industries of different types located adjacent to the Hudiara drain on the 55 kilometers Indian side, so it is already quite polluted when it enters Pakistan [7].

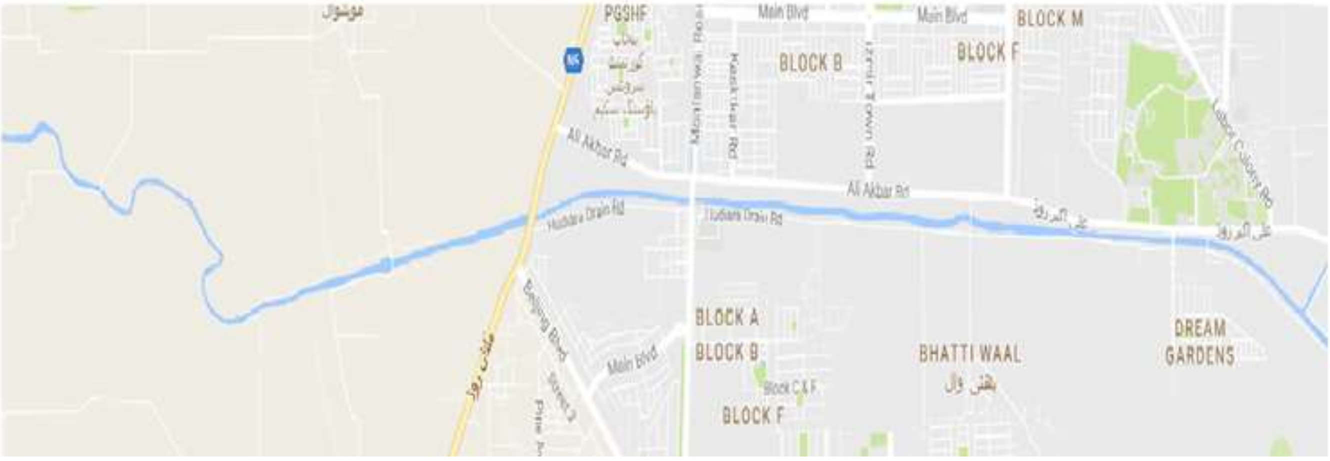

Fig.1: Hudiara Drain in Map.

There are 112 small industries located next to the drain on Pakistani side as it travels 63 kilometers before entering into the Ravi. This water is also being used for irrigation along the length of the drain by using different methods. The villagers even use water from wells dug close to the drain, which are exposed to the pollution through seepage. With increasing water shortage for agriculture and increasing waste water volume in drains, farmers around these drains find it convenient to irrigate the fields with easily accessible and free of cost drain water. Untreated water, when used for irrigation, seeps into the soil and facilitates the entry of a number of pathogens and heavy metals into the food chain. Vegetables and other crops grown with polluted water may also have exceeded levels of heavy metals which may cause diseases when consumed by people or by animals.

Therefore, the present study has been undertaken with following objectives.

1- Assessment of heavy metals concentration in Hudiara Drain water.
2- Investigation of the concentration of heavy metals in different fodder crops grown with this drain water.

II. MATERIALS AND METHODS

A survey was conducted along the Hudiara drain inside Lahore city and ten different sites were selected along Hudiara drain at a distance of three kilometers from each other. The sites were selected where Hudiara drain water is being used for irrigating fodder crops and these fodder crops are being grazed by the cattles.

Water samples were collected directly from the Hudiara drain and also from the tube wells installed at the banks of Hudiara drain and the tube wells directly pumping the water of Hudiara drain and using it for irrigating of fodder crops. Water samples were collected from different points within the distance of 3 kilometers. Five water samples were collected from each site. Water samples were collected in Polythene bottles washed with distilled water and dried. The water samples were filtered through Whatman filter paper no 42 and acidified with few drops of 1 N Nitric Acid and stored for further analyses in clean polythene bottles washed with distilled water. These samples were properly labeled, for storage and further analyses. Leaves samples of Fodder crops, Berseem, Bajra, Maize and Oat were collected from the fields irrigated with the tube wells directly pumping the water of Hudiara drain and also from the tube wells installed near the banks of Hudiara drain. Fodder crops samples were collected from three different points of a site within the distance of 3 kilometers. Leaves samples were washed with distilled water, dried with blotting paper. Then the samples were air dried and then dried in oven till constant weight. The fodder crops samples were digested with double acid mixture in fume hood and were stored for analyses after making required volume.

The stored water and plant samples were subjected to heavy metals analyses including Lead, Cadmium, Chromium, Nickel, Zinc, Iron, Copper and Manganese on Atomic Absorption Spectrophotometer [8] and were compared with Maximum Recommended Concentrations. The data was also subjected to mean and percentage.

III. RESULTS AND DISCUSSION

HEAVY METALS CONTAMINATION IN HUDIARA DRAIN WATER

Heavy metals including Lead, Cadmium, Chromium, Nickel, Zinc, Iron, Copper and Manganese contamination showed quite a large variation in Hudiara drain water (Table 1 and 2) and data was classified into safe and unsafe samples for irrigation considering the MRCs (Maximum Recommended Concentrations) provided by Food and Agriculture Organization (1985).

Lead contents in Hudiara drain water ranged from 0.01 mg L^{-1} to 0.15 mg L^{-1} and all the water samples were below the Maximum Recommended Concentrations recommended by Food and Agriculture Organization

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(1985). Hence, Lead pollution was not found in Hudiara drain water regarding irrigation. Whereas, Cadmium contamination was shown in Hudiara drain water. Cadmium contents in Hudiara drain ranged from 0.03 mg L^{-1} to 0.18 mg L^{-1} and all the samples were above the Maximum Recommended Concentrations given by FAO [9]. Chromium contents in Hudiara drain water showed a large variation and contents ranged from 0.02 mg L^{-1} to 0.17 mg L^{-1}. The data was classified into safe and unsafe considering the Maximum Recommended Concentrations given by FAO (1985) and data showed that 37 samples being 74% were safe and remaining 13 (26%) samples were unsafe for irrigation according to the guidelines of FAO. Similarly, Nickel contamination in Hudiara drain water also showed huge variation and contents ranged from 0.07 mg L^{-1} to 0.93 mg L^{-1}. The data was classified into safe and unsafe regarding Nickel contamination considering the Maximum Recommended Concentrations given by FAO (1985) and data showed that 5 samples being 10% were safe and remaining 45 (90%) samples were unsafe considering the guidelines of FAO.

Zinc contents in Hudiara drain water ranged from 0.03 mg L^{-1} to 0.19 mg L^{-1} and all the water samples were below the Maximum Recommended Concentrations recommended by Food and Agriculture Organization (1985). Hence, Zinc pollution was not found in Hudiara drain water regarding irrigation. Whereas, Iron contamination was shown in Hudiara drain water. Iron contents in Hudiara drain ranged from 2.1 mg L^{-1} to 8.7 mg L^{-1} and 54% samples were below the Maximum Recommended Concentrations given by FAO (1985) and 46% were above. Copper contents in Hudiara drain water showed a large variation and contents ranged from 0.03 mg L^{-1} to 0.42 mg L^{-1}. The data was classified into safe and unsafe considering the Maximum Recommended Concentrations given by FAO (1985) and data showed that 50% samples were safe and remaining 50% samples were unsafe for irrigation according to the guidelines of FAO. Manganese contamination in Hudiara drain water also showed huge variation and contents ranged from 0.11 mg L^{-1} to 0.90 mg L^{-1}. The data was classified into safe and unsafe regarding Nickel contamination considering the Maximum Recommended Concentrations given by FAO (1985) and data showed that 41 samples being 82% were safe and remaining 18% samples were unsafe considering the guidelines of FAO.

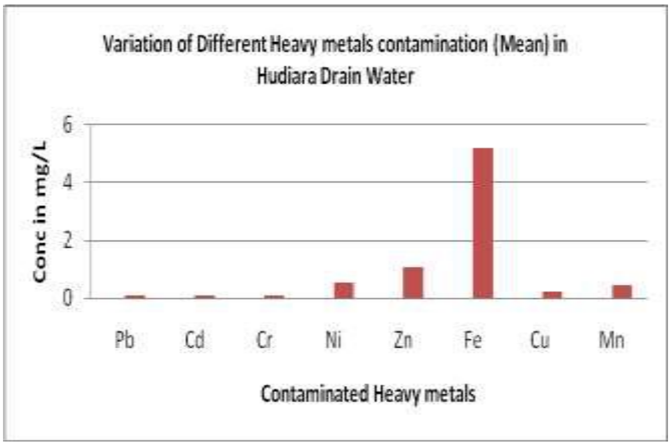

Fig.2: Variation of Different Heavy metals contamination (Mean) in Hudiara Drain Water.

Table.1: Heavy Metals Contamination (Mg/L) In Hudiara Drain Water

S. No	Site	Pb	Cd	Cr	Ni	Zn	Fe	Cu	Mn
1.	Site 1	0.03	0.13	0.07	0.60	1.1	2.1	0.12	**0.31**
2.		0.09	0.06	0.03	0.76	1.9	4.9	0.21	**0.35**
3.		0.15	0.07	0.05	0.52	0.03	4.4	0.32	**0.71**
4.		0.13	0.03	0.10	0.93	1.5	2.2	0.14	**0.11**
5.		0.07	0.04	0.15	0.21	0.04	7.2	0.01	**0.27**
6.	Site 2	0.09	0.12	0.12	0.75	1.4	5.4	0.06	**0.76**
7.		0.05	0.18	0.07	0.87	1.8	4.3	0.23	**0.62**
8.		0.07	0.10	0.05	0.62	0.09	6.3	0.15	**0.37**
9.		0.13	0.11	0.06	0.73	1.3	7.2	0.03	**0.13**
10.		0.12	0.09	0.02	0.86	1.7	5.4	0.34	**0.26**
11.	Site 3	0.11	0.03	0.08	0.22	0.06	6.4	0.45	**0.79**
12.		0.09	0.04	0.09	0.82	1.3	5.2	0.17	**0.62**
13.		0.04	0.09	0.06	0.31	1.2	6.0	0.07	**0.82**
14.		0.03	0.12	0.07	0.29	0.09	7.2	0.04	**0.30**
15.		0.09	0.15	0.09	0.71	1.8	8.7	0.24	**0.15**
16.	Site 4	0.12	0.03	0.12	0.82	0.07	7.4	0.37	**0.23**
17.		0.10	0.05	0.13	0.64	1.5	5.2	0.42	**0.52**
18.		0.14	0.12	0.03	0.53	1.1	4.0	0.18	**0.61**

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19.		0.13	0.11	0.09	0.72	0.08	6.5	0.05	**0.42**
20.		0.15	0.09	0.15	0.81	1.3	4.2	0.25	**0.19**
21.		0.01	0.12	0.07	0.60	1.2	4.3	0.32	**0.29**
22.		0.04	0.16	0.06	0.41	0.03	2.6	0.08	**0.90**
23.	Site 5	0.12	0.10	0.09	0.52	1.4	6.2	0.02	**0.67**
24.		0.10	0.02	0.17	0.79	1.9	7.5	0.19	**0.17**
25.		0.15	0.03	0.08	0.80	0.05	5.2	0.41	**0.19**
26.		0.09	0.05	0.03	0.43	1.5	4.1	0.09	**0.62**
27.		0.06	0.07	0.13	0.74	1.4	6.8	0.24	**0.25**
28.	Site 6	0.07	0.07	0.15	0.32	1.6	3.2	0.42	**0.71**
29.		0.12	0.12	0.06	0.42	1.7	5.0	0.10	**0.62**
30.		0.05	0.03	0.09	0.12	1.4	7.2	0.21	**0.82**
31.		0.10	0.04	0.13	0.21	0.06	3.6	0.06	**0.21**
32.		0.13	0.05	0.05	0.83	1.4	5.1	0.19	**0.13**
33.	Site 7	0.01	0.09	0.06	0.07	1.8	7.8	0.25	**0.23**
34.		0.03	0.12	0.09	0.41	0.07	3.5	0.30	**0.65**
35.		0.05	0.13	0.05	0.23	1.5	4.2	0.43	**0.32**
36.		0.09	0.15	0.12	0.84	1.9	5.1	0.07	**0.15**
37.		0.12	0.09	0.04	0.73	1.6	7.2	0.15	**0.90**
38.	Site 8	0.13	0.06	0.14	0.62	0.09	3.9	0.42	**0.76**
39.		0.15	0.03	0.03	0.08	1.9	4.5	0.27	**0.62**
40.		0.13	0.03	0.06	0.51	1.6	6.7	0.37	**0.21**
41.		0.14	0.07	0.11	0.85	0.08	4.0	0.08	**0.17**
42.		0.06	0.03	0.07	0.79	1.2	5.2	0.13	**0.82**
43.	Site 9	0.03	0.04	0.04	0.08	1.7	6.8	0.39	**0.43**
44.		0.11	0.05	0.02	0.09	1.6	3.8	0.41	**0.22**
45.		0.09	0.06	0.03	0.87	0.03	6.2	0.09	**0.75**
46.		0.06	0.07	0.10	0.69	1.3	3.7	0.12	**0.50**
47.		0.01	0.10	0.03	0.15	1.8	4.2	0.32	**0.20**
48.	Site 10	0.07	0.12	0.09	0.46	0.04	4.3	0.29	**0.41**
49.		0.06	0.09	0.06	0.55	1.4	3.9	0.12	**0.55**
50.		0.06	0.08	0.08	0.39	1.7	4.2	0.27	**0.26**
Average		0.087	0.0806	0.0792	0.5464	1.0862	5.204	0.2132	**0.4454**
MRCs*		5.0	0.01	0.10	0.20	2.0	5.0	0.20	**0.20**
No. of samples Safe		50 (100%)	0 (0%)	37 (74%)	5 (10%)	0/50 (0%)	27/50 (54%)	25/50 (50%)	**41/50 (82%)**
No. of samples Unsafe		**0 (0%)**	**50 (100%)**	**13 (26%)**	**45 (90%)**	**50/50 (100%)**	**23/50 (46%)**	**25/50 (50%)**	**9/50 (18%)**

*Maximum Recommended Concentrations in Irrigation water (FAO, 1985)

Table.2: Site Wise Comparisons of Heavy Metals in Hudiara Drain Water.

	Pb	Cd	Cr	Ni	Zn	Fe	Cu	Mn
Site 1	0.094	0.066	0.08	0.604	0.9	4.16	0.16	0.35
Site 2	0.092	0.12	0.064	0.766	1.26	5.72	0.17	0.43
Site 3	0.072	0.086	0.078	0.47	0.89	6.7	0.19	0.54
Site 4	0.128	0.080	0.104	0.704	0.81	5.46	0.25	0.39
Site 5	0.084	0.086	0.094	0.624	0.92	5.16	0.20	0.44
Site 6	0.078	0.068	0.092	0.406	1.52	5.26	0.21	0.60

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Site 7	0.064	0.086	0.076	0.35	0.97	4.84	0.25	0.31
Site 8	0.124	0.072	0.078	0.556	1.42	5.48	0.26	0.53
Site 9	0.086	0.086	0.054	0.536	0.92	5.2	0.22	0.48
Site 10	0.052	0.052	0.072	0.448	1.25	4.06	0.22	0.38

Table.3: Descriptive Statistics of Different Elements in Hudiara Drain

	Mean	Std. Deviation	N
Pb	.0874	.04135	50
Cd	.0836	.03963	50
Cr	.0792	.03870	50
Ni	.5464	.26059	50
Zn	1.0862	.70755	50
Fe	5.2040	1.55037	50
Cu	.2132	.13168	50
Mn	.4162	.24025	50

In **table 3** a low standard deviation indicates that the points are close to the mean and the expected value of the set close to the actual value.

Table.4: Correlation between the Heavy Metals of Hudiara Drain

		Pb	Cd	Cr	Ni	Zn	Fe	Cu	Mn
Pb	Pearson Correlation	1	.341*	.085	.396**	-.111	.022	.033	-.029
	Sig. (2-tailed)		.015	.555	.004	.444	.879	.822	.841
Cd	Pearson Correlation	.341*	1	.092	.354*	.054	.035	-.053	-.096
	Sig. (2-tailed)	.015		.523	.012	.710	.808	.716	.508
Cr	Pearson Correlation	.085	.092	1	.217	-.178	.057	-.045	-.163
	Sig. (2-tailed)	.555	.523		.129	.216	.695	.756	.258
Ni	Pearson Correlation	.396**	.354*	.217	1	-.014	-.011	-.215	-.079
	Sig. (2-tailed)	.004	.012	.129		.925	.942	.134	.587
Zn	Pearson Correlation	-.111	.054	-.178	-.014	1	.048	.090	-.064
	Sig. (2-tailed)	.444	.710	.216	.925		.742	.535	.657
Fe	Pearson Correlation	.022	.035	.057	-.011	.048	1	-.074	-.148
	Sig. (2-tailed)	.879	.808	.695	.942	.742		.612	.304
Cu	Pearson Correlation	.033	-.053	-.045	-.215	.090	-.074	1	-.107
	Sig. (2-tailed)	.822	.716	.756	.134	.535	.612		.458
Mn	Pearson Correlation	-.029	-.096	-.163	-.079	-.064	-.148	-.107	1
	Sig. (2-tailed)	.841	.508	.258	.587	.657	.304	.458	
	*. Correlation is significant at the 0.05 level (2-tailed).								
	**. Correlation is significant at the 0.01 level (2-tailed).								

In table 4 there is positive correlation between lead (Pb^{+2}) with cadmium (Cd^{+2}), chromium Cr $^{+3}$, Nickle (Ni^{+2}). There is negative correlation between lead (Pb^{+2}) with Zinc (Zn^{+2}) , manganese (Mn^{+2}). There is weak positive correlation between Cd $^{+2}$ with Pb $^{+2}$, Ni^{+2}, Zn $^{+2}$, Fe^{+2}, Cr+3 where there is negative correlation among copper (Cu^{+2}) and (Cd $^{+2}$). There is positive correlation between Cr $^{+3}$ with Pb $^{+2}$, Cd $^{+2}$, Ni^{+2} ,Fe^{+2}, Cu^{+2} where there is negative correlation between Cr^{+3} between with Mn^{+2} and Zn^{+2}.There is positive correlation between Ni^{+2} with Pb^{+2}, Cd^{+2}, Cr^{+3}, Zn^{+2}.Where there is negative correlation between Ni^{+2} with Fe^{+2}, Cu^{+2}, Mn^{+2}.There is positive correlation between Zn^{+2} with Cd^{+2}, Ni^{+2}, Fe^{+2}, Cu^{+2} and Mn^{+2}. There is positive correlation between Fe^{+2} with

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Pb^{+2}, Cd^{+2}, Cr^{+2}, Zn^{+2} and negative correlation between Fe^{+2} and Ni^{+2} , Cu^{+2} and Mn^{+2}. There is positive correlation between Cu^{+2} with Pb^{+2}, Zn^{+2}. There is negative correlation between Mn^{+2} and Pb^{+2}, Cd^{+2}, Cr^{+3},Ni^{+2}, Fe^{+2}, Cu^{+2}.

HEAVY METALS CONTAMINATION IN FODDER CROPS SAMPLES IRRIGATED WITH HUDIARA DRAIN WATER

Heavy metals including Lead, Cadmium, Chromium, Nickel, Zinc, Iron, Copper and manganese contamination in fodder crops irrigated with Hudiara drain water given in Table 3 & 4 showed quite a large variation and data was classified into safe and unsafe samples considering the Critical levels described by Asaolu [10] and WHO [11]. Lead contents in fodder crops irrigated with Hudiara drain water ranged from 0.2 mg kg^{-1} to 4.2 mg kg^{-1} and 50% (15 No.) samples were below the Critical levels recommended by Asaolu. Hence, Lead pollution was found in fodder crops irrigated with Hudiara drain water. Cadmium contamination was shown in fodder crops irrigated with Hudiara drain water as the Hudiara drain water was contaminated with Cadmium and that depicted in fodder crops irrigated with Hudiara drain.

Cadmium contents in Hudiara drain irrigated fodder crops ranged from 0.7 mg kg^{-1} to 3.1 mg kg^{-1} and all the samples were above the Critical levels described by WHO (1996). Chromium contents in fodder crops irrigated with Hudiara drain water showed contamination and contents ranged from 4.0 mg kg^{-1} to 32.0 mg kg^{-1}. The data was classified into safe and unsafe considering the Critical levels described by Asaolu (1995) and data showed that all samples were unsafe according to the guidelines given by Asaolu (1995). Nickel contamination in Hudiara drain water irrigated fodder crops also showed variation and contents ranged from 4.0 mg kg^{-1} to 16.2 mg kg^{-1}. The data was classified into safe and unsafe regarding Nickel contamination considering the critical levels given by WHO (1996) and data showed that 19 (63.4%) samples were safe and remaining 11 (36.7%) samples were unsafe.

Zinc contents in fodder crops irrigated with Hudiara drain water ranged from 4.0 mg kg^{-1} to 64.0 mg kg^{-1} and 17% samples were below the Critical levels recommended by Soltanpur (1985). Hence, Zinc pollution was found in fodder crops irrigated with Hudiara drain water. Iron contamination was shown in fodder crops irrigated with Hudiara drain water ranged from 1000 mg kg^{-1} to 3801 mg kg^{-1} and all the samples were above the critical levels described by Soltanpur (1985). Copper contents in fodder crops irrigated with Hudiara drain water showed contamination and contents ranged from 50 mg kg^{-1} to 319 mg kg^{-1}. The data was classified into safe and unsafe considering the critical levels described by Soltanpur (1985) and data showed that all samples were unsafe according to the guidelines given by Soltanpur (1985). Manganese contamination in Hudiara drain water irrigated fodder crops also showed variation and contents ranged from 25 mg kg^{-1} to 140 mg kg^{-1}. The data was classified into safe and unsafe regarding Nickel contamination considering the critical levels given by Soltanpur (1985) and data showed that all samples were unsafe.

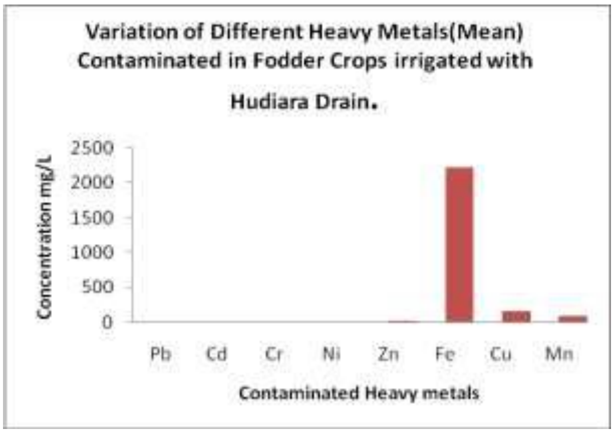

Fig.3: Variation of Different Heavy Metals (Mean) Contaminated in Fodder Crops irrigated with Hudiara Drain.

Cadmium contents in Hudiara drain irrigated fodder crops ranged from 0.7 mg kg^{-1} to 3.1 mg kg^{-1} and all the samples were above the Critical levels described by WHO (1996). Chromium contents in fodder crops irrigated with Hudiara drain water showed contamination and contents ranged from 4.0 mg kg^{-1} to 32.0 mg kg^{-1}. The data was classified into safe and unsafe considering the Critical levels described by Asaolu (1995) and data showed that all samples were unsafe according to the guidelines given by Asaolu (1995). Nickel contamination in Hudiara drain water irrigated fodder crops also showed variation and contents ranged from 4.0 mg kg^{-1} to 16.2 mg kg^{-1}. The data was classified into safe and unsafe regarding Nickel contamination considering the critical levels given by WHO (1996) and data showed that 19 (63.4%) samples were safe and remaining 11 (36.7%) samples were unsafe.

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according to the guidelines given by Soltanpur (1985). Manganese contamination in Hudiara drain water irrigated fodder crops also showed variation and contents ranged from 25 mg kg^{-1} to 140 mg kg^{-1}. The data was classified into safe and unsafe regarding Nickel contamination considering the critical levels given by Soltanpur (1985) and data showed that all samples were unsafe.

Table.5: Heavy Metals Contamination in Fodder Crops Irrigated with Hudiara Drain

S. No	Site	Pb	Cd	Cr	Ni	Zn	Fe	Cu	Mn
1	Site 1	2.4	0.8	4.2	10.2	15.2	2502	131	71
2		3.7	1.8	12.0	5.9	20.1	2851	202	121
3		1.9	2.6	21.5	4.5	25.4	1215	217	109
4	Site 2	1.8	1.2	25.4	12.4	45.2	1527	117	127
5		0.2	2.7	27.3	4.9	59.5	2215	319	85
6		2.6	2.9	4.9	5.2	4.0	1000	145	121
7	Site 3	2.0	3.1	14.4	4.9	16.4	2973	50	37
8		1.7	1.9	23.2	11.7	27.8	1259	151	82
9		0.6	0.9	27.0	5.3	47.0	1571	209	121
10	Site 4	2.7	1.6	29.2	8.1	60.2	1210	201	125
11		3.9	3.0	9.2	5.6	4.6	2413	52	25
12		1.6	2.8	25.7	12.9	17.2	2581	177	90
13	Site 5	0.7	3.0	28.5	7.6	29.0	1107	301	119
14		2.9	0.8	25.4	6.2	49.5	1505	215	127
15		2.5	2.0	16.2	13.2	64.0	2619	91	42
16	Site 6	0.5	1.5	5.2	7.2	4.9	3801	181	77
17		1.4	2.1	27.8	6.7	19.4	2504	231	137
18		3.0	0.7	29.5	14.5	31.5	1709	99	131
19	Site 7	4.1	2.2	30.2	9.1	50.4	2425	192	41
20		0.9	2.1	6.7	7.1	61.5	2725	245	92
21		1.2	2.8	17.5	15.6	4.5	3235	201	139
22	Site 8	3.3	1.2	29.5	8.9	20.5	3445	257	57
23		3.9	2.3	32.0	8.5	33.3	1959	137	103
24		0.8	1.9	7.2	16.2	54.2	2231	125	140
25	Site 9	1.9	2.5	9.7	12.8	25.4	1905	110	59
26		4.2	1.5	18.2	9.6	4.7	2125	212	109
27		2.1	2.5	31.5	15.7	21.2	2702	258	140
28	Site 10	1.0	1.6	20.5	10.5	39.4	1702	129	63
29		3.5	2.3	10.1	9.5	32.5	3199	102	117
30		3.7	1.7	16.1	12.5	4.8	2506	125	51
Average		2.23	2.0	19.53	9.43	29.77667	2224.033	172.7333	95.26667
Critical Levels		2.0*	0.02**	1.30*	10.00**	5.0	150.0	10.00	6.61
No. of samples Safe		15 (50%)	0 (0%)	0 (0%)	19 (63.4%)	6/30 (20%)	0/30 (0%)	0/30 (0%)	0/30 (0%)
No. of samples Unsafe		15 (50%)	30 (100%)	30 (100%)	11 (36.7%)	24/30 (80%)	30/30 (100%)	30/30 (100%)	30/30 (100%)

Source: * Asaolu, 1995; ** WHO, 1996.

Table.6: Site Wise Comparison of Heavy Metals in Hudiara Drain Irrigated Fodder Crops

	Pb	Cd	Cr	Ni	Zn	Fe	Cu	Mn
Site 1	2.67	1.73	12.56	6.87	20.23	2189.33	183.33	100.33
Site 2	1.53	2.27	19.2	7.5	36.23	1580.66	193.36	111.0
Site 3	1.43	1.97	21.53	7.3	30.4	1934.3	136.66	80.0
Site 4	2.73	2.47	21.36	8.87	27.33	2068.0	143.33	80.0

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Site 5	2.03	1.93	23.36	9.0	47.5	1743.66	202.33	96.0
Site 6	1.63	1.43	20.83	9.47	18.6	2671.33	170.33	115.0
Site 7	2.07	2.37	18.13	10.6	38.8	2795.0	212.66	90.6
Site 8	2.67	1.8	22.9	11.2	36.0	2545.0	173.00	100.0
Site 9	2.73	2.17	19.8	12.7	17.1	2244.0	193.33	102.66
Site 10	2.73	1.87	15.56	10.83	25.57	2469.0	118.66	77.0

Table.7: Descriptive Statistics of Heavy Metals in Hudiara Drain Irrigated Fodder Crops.

Metals in Fodder Crop	Mean	Std. Deviation	N
Pb	2.3733	1.25861	30
Cd	2.2400	1.28321	30
Cr	19.5267	9.22945	30
Ni	9.4333	3.59015	30
Zn	29.7633	19.29190	30
Fe	2.2240	739.31718	30
Cu	1.7273	68.19897	30
Mn	95.2667	35.44197	30

In **table 7** a low standard deviation of Pb $^{+2}$, Cd^{+2},Cr^{+3},Ni^{+2} and Zn^{+2} indicates that the points are close to the mean and the expected value of the set close to the actual value. Where high standard deviation of Cu^{+2} and Mn^{+2} indicates that the points are not close to the mean and the expected values are not to the actual value. In table 8 there is positive correlation between Pb^{+2} and Fe^{+2} where there is negative correlation between Pb^{+2} and Cr^{+2} ,Cd^{+2}, Ni^{+2}, Zn^{+2}, Cu+2. Mn^{+2}. There is positive correlation between Cr^{+2} and Cd^{+2}, Ni^{+2}, Zn^{+2}, Cu^{+2}, Mn^{+2}. In case of Ni^{+2} there is negative correlation between Ni^{+2} and Cu^{+2}, Pb^{+2}, Cd^{+2} where there is positive correlation between Ni^{+2} and Zn^{+2}, Cr^{+2}, Fe^{+2}, Mn^{+2}. In case of Zn^{+2} there is positive correlation between Zn^{+2} and Cd^{+2}, Cr^{+2}, Ni $^{+2}$, Cu^{+2}, Mn^{+2} where there is negative correlation between Pb^{+2} and Cu^{+2}. There is positive correlation between Fe^{+2} and Pb^{+2}, Ni^{+2} where there is negative correlation Fe^{+2} and Cd^{+2}, Cr^{+2}, Zn^{+2}, Cu^{+2}, Mn^{+2} .

Table.8: Correlation of Heavy Metals in Hudiara Drain Irrigated Fodder Crops.

		Pb	Cd	Cr	Ni	Zn	Fe	Cu	Mn
Pb	Pearson Correlation	1	-.031	-.143	-.092	-.398*	.331	-.303	-.280
	Sig. (2-tailed)		.870	.452	.629	.030	.074	.104	.135
Cd	Pearson Correlation	-.031	1	.059	-.248	.072	-.154	.131	.082
	Sig. (2-tailed)	.870		.758	.186	.706	.417	.489	.665
Cr	Pearson Correlation	-.143	.059	1	.057	.288	-.299	.436*	.235
	Sig. (2-tailed)	.452	.758		.764	.122	.108	.016	.212
Ni	Pearson Correlation	-.092	-.248	.057	1	.006	.143	-.240	.151
	Sig. (2-tailed)	.629	.186	.764		.973	.451	.202	.425
Zn	Pearson Correlation	-.398*	.072	.288	.006	1	-.277	.171	.095
	Sig. (2-tailed)	.030	.706	.122	.973		.138	.367	.619
Fe	Pearson Correlation	.331	-.154	-.299	.143	-.277	1	-.049	-.285
	Sig. (2-tailed)	.074	.417	.108	.451	.138		.797	.127
Cu	Pearson Correlation	-.303	.131	.436*	-.240	.171	-.049	1	.391*
	Sig. (2-tailed)	.104	.489	.016	.202	.367	.797		033
Mn	Pearson Correlation	-.280	.082	.235	.151	.095	-.285	.391*	1
	Sig. (2-tailed)	.135	.665	.212	.425	.619	.127	.033	

In table 8 there is positive correlation between Pb^{+2} and Fe^{+2} where there is negative correlation between Pb^{+2} and Cr^{+2} ,Cd^{+2}, Ni^{+2}, Zn^{+2}, Cu+2. Mn^{+2}. There is positive correlation between Cr^{+2} and Cd^{+2}, Ni^{+2}, Zn^{+2}, Cu^{+2}, Mn^{+2}. In the case of Ni^{+2} there is negative correlation between Ni^{+2} and Cu^{+2}, Pb^{+2}, Cd^{+2} where there is positive

correlation between Ni^{+2} and Zn^{+2}, Cr^{+2}, Fe^{+2}, Mn^{+2}. In the case of Zn^{+2} there is positive correlation between Zn+2 and Cd+2, Cr^{+2}, Ni $^{+2}$, Cu^{+2}, Mn^{+2} where there is negative correlation between Pb^{+2} and Cu^{+2}. There is correlation between Fe^{+2} and Pb^{+2}, Ni^{+2} where there is negative correlation Fe^{+2} and Cd^{+2}, Cr^{+2}, Zn^{+2}, Cu^{+2}, Mn^{+2}.

Table.9: Correlation between the Heavy Metals of Hudiara Drain and Fodder Copper Irrigated with Heavy Metals.

		Pb	Cd	Cr	Ni	Zn	Fe	Cu	Mn
Pb Fodder Crop	Pearson Correlation	.128	.172	-.378*	-.101	-.155	.056	-.011	.314
	Sig. (2-tailed)	.499	.364	.039	.595	.414	.767	.954	.091
Cd Fodder Crop	Pearson Correlation	-.318	-.257	.050	-.257	-.273	.320	-.118	-.137
	Sig. (2-tailed)	.086	.170	.792	.170	.144	.084	.535	.471
Cr Fodder Crop	Pearson Correlation	-.052	-.344	-.204	-.151	-.103	.046	-.296	.132
	Sig. (2-tailed)	.783	.062	.279	.425	.590	.810	.113	.487
Ni Fodder Crop	Pearson Correlation	-.131	-.189	.116	.160	.247	-.013	.118	-.259
	Sig. (2-tailed)	.492	.318	.540	.398	.188	.945	.533	.167
Zn Fodder Crop	Pearson Correlation	.306	.045	.219	.157	.083	.243	-.223	-.298
	Sig. (2-tailed)	.100	.815	.246	.408	.665	.196	.236	.110
Fe Fodder Crop	Pearson Correlation	-.189	.064	.169	.077	.028	-.016	.188	-.040
	Sig. (2-tailed)	.317	.738	.373	.687	.881	.932	.319	.835
Cu Fodder Crop	Pearson Correlation	-.192	-.464**	.090	-.151	-.225	.069	-.279	-.048
	Sig. (2-tailed)	.309	.010	.637	.427	.231	.716	.135	.801
Mn Fodder Crop	Pearson Correlation	.042	-.278	-.038	.196	.355	-.057	-.177	-.068
	Sig. (2-tailed)	.827	.137	.841	.299	.055	.763	.348	.720

In the above table the Pb^{+2} of Hudiara drain and irrigated Pb^{+2} of fodder crop there positive correlation where there is also correlation Pb^{+2} of Hudiara drain water and fodder crop irrigated with Hudiara drain water and negative correlation between Pb^{+2} and Cr^{+2}, Ni^{+2}, Cu^{+2}. There is positive correlation between Cd^{+2} and Cr^{+2}, Fe^{+2} and also negative correlation between Cd^{+2} and Pb^{+2}, Cd^{+2}, Ni^{+2}, Zn^{+2}, Cu^{+2}, Mn^{+2} of fodder crop irrigated with Hudiara drain.

Some of the heavy metals are essential and some are even not essential for plant growth but after accumulating in the soil are transferred to food chain [4]. These metal ions are either themselves toxic to biological organisms or induce deficiency of others [13]. These metals have their permissible limits quite low and show toxicity on plants, animals and human beings above their permissible limits [14]. Generally, our farmers are not aware of the metal ion toxicity being introduced into food chain by vegetables/ crops grown with these polluted waters [15]. These heavy metals reduce the activity of hydrolysis viz., α amylase, phosphatase, RNAse and proteins. They interfere in the enzyme action by replacing metal ions from the metaloenzymes. Among heavy metals cadmium shows severe effect on seedling length, dry weight, causes structural change in chloroplast, reduces photosystem-II activity, reduces process of photosynthesis, availability of carbon dioxide, reduce glycolipids, neutral lipids and total lipids, lowers stomatal conductance, interfere membrane permeability and reduce respiration in leaves [12]. Toxic level of lead inhibits seed germination, reduces transpiration, reduce rate of photosynthesis, alters relative proportion of chlorophyll a and chlorophyll b, causes reduction in total chlorophyll production, and reduce gaseous exchange in leaves. Similarly toxicity of nickel and chromium showed drastic effect on dry matter production and crop yield [12].

IV. CONCLUSION

Sewage and Industrial wastes are big source of Heavy metals in drains, almost above the Maximum Recommended Concentrations and this water is used for irrigating fodder crops that causes exceeded amounts of Heavy metals, dangerous for animals and human's health. These heavy metals contaminated crops are grazed by cattles and cattle milk also have high quantities of these metals, which is also carcinogenic to human's health. Hence, it's the need of time to treat the contaminated water before throwing into drains or not to use this contaminated water for irrigation/drinking purpose, also the Government should emphasize and made regulations for this purpose.

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